Submission in Response to NSF CI 2030 Request for Information

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Research Domain, discipline, and sub-discipline

Nanotechnology (nanotoxicology, nanomedicine)

Title of Submission

Optimizing information extraction and knowledge generation

Abstract (maximum ~200 words).

Timely access to existing knowledge in the information age is a major challenge to emerging science and engineering research.

Question 1 Research Challenge(s) (maximum ~1200 words): Describe current or emerging science or engineering research challenge(s), providing context in terms of recent research activities and standing questions in the field.

A major challenge to emerging science and engineering research is timely access to existing knowledge in the information age. More and more people are interested in participating in research endeavors. Emphasis on outreach is leading to broader participation within science and engineering as well as inclusion of community members in research activities through citizen science. With mass volumes of data being collected and shared, the data science community needs to think deeply about how to maximize knowledge generation from this data as resources (i.e. research funding, access to major equipment) become more limited.
In the area of nanotechnology, engineered nanomaterials are incorporated into a wide variety of products (e.g. medicines, photovoltaics, filters) and apply their unique physico-chemical properties in different ways. Often times, researchers in different fields are studying the same material yet are unaware of the findings in other fields. It is unfortunate that newcomers to nanotechnology often repeat mistakes veteran researchers have encountered and may have extensively explored due to lack of awareness of the work. I believe that this repeating of past mistakes is not because the information was not shared or published but the information is not easily nor quickly discoverable in the vast sea of publications available online. This filter/relevancy/signal-to-noise failure needs to be addressed and, in my opinion, presents a formidable research challenge.

Question 2 Cyberinfrastructure Needed to Address the Research Challenge(s) (maximum ~1200 words): Describe any limitations or absence of existing cyberinfrastructure, and/or specific technical advancements in cyberinfrastructure (e.g. advanced computing, data infrastructure, software infrastructure, applications, networking, cybersecurity), that must be addressed to accomplish the identified research challenge(s).

To advance knowledge generation, our methods of sharing data need to be enhanced and new methods need to be adopted. For example, in my move towards electronic laboratory notebooks and incorporation of laboratory automation + informatics, it has been difficult to learn from others as there are few research groups that have migrated away from paper notebooks and conventional instrument data transfer. I believe it is only a matter of time until more labs move towards real-time data transfer to electronic laboratory notebooks or online data repositories. However, will our cyberinfrastructure grow at the same pace as laboratories, buildings, public works, and others move to wireless and cloud-based data transfer and storage? Are we prepared for the other costs (e.g. land space, energy consumption, security)? What metrics will we use to decide what to preserve and/or maintain over time?